Refueling boom lowered from KC–135E during mid-air refueling mission
305th Communications Squadron (Kenn Mann)

Energy and Force Transformation

By SCOTT C. BUCHANAN

Early in the 20th century, First Sea Lord Sir John Fisher implemented a radical transformation that both altered the British Navy's force structure and diversified its energy sources. Although military and strategic considerations loomed large in this transformation, the overriding driver was the problem of limited government finances.[1] Because oil was a more efficient form of energy than coal, the British admiralty judged that it could secure savings in its most critical problem area—manpower—by shifting from a coal-based to an oil-based energy infrastructure.

As the Royal Navy diversified its energy sources to include both coal and oil, its logistical infrastructure changed as well. Because Britain lacked domestic supplies of oil, some of the key issues that challenged this energy transformation were the diversification of suppliers, storage of the oil, and transport. Despite the peacetime innovations, the navy still found fuel consumption to be its greatest logistical challenge in World War I.[2]

The U.S. Department of Defense (DOD) can learn from the Royal Navy's pre–World War I energy transformation. Like the Royal Navy a century ago, DOD is faced with the problem of limited resources due in large part to our energy infrastructure. Fuel represents more than half of the DOD logistics tonnage and over 70 percent of the tonnage required to put the U.S. Army into position for battle.[3] The Navy uses millions of gallons of fuel every day to operate around the globe, and the Air Force, the largest daily DOD consumer of fuel, uses even more.[4]

The DOD energy burden is so significant that it may prevent the execution of new and still evolving operational concepts, which require the rapid and constant transport of resources without regard for the energy costs.[5] These energy burdens will increase as new operational concepts demand a lighter, more agile and dispersed force, with the attendant increase in logistical sustainment. As increasing portions of the budget are set aside for fuel purchases to account for the volatility in fuel prices, increased capability will need to be built into new platforms to mitigate likely impacts on force shape and composition. It is crucial, therefore, that DOD develops an energy strategy that reduces the energy burdens of our operational concepts.

Decoupling traditional energy sources from systems and platforms may radically alter both operational requirements and capabilities, as well as alter strategic realities. The use of technologies that no longer rely on the current energy infrastructure is the wave of the future. For instance, one estimate suggests that a third of DOD resources are focused on one small area of the world—the Middle East. The annual investment in securing this region currently exceeds $150 billion per year.[6] Reducing our dependency on oil should make these resources available for investment in future force and infrastructure needs.

Depending upon which view one chooses to accept, the global oil supply will either last no more than a few decades or will perhaps last a century. On one side of the debate, experts argue that because of the limited supply of oil, it will increase in expense as it depletes in availability or production (referred to as Hubbert's peak). Market analysts, on the other hand, argue that the market will force a correction of the oil demand, thereby stemming the flow of oil and prolonging the inevitable. Both arguments underscore that oil is an increasingly scarce commodity. Clayton Christensen has argued that "markets that don't exist can't be analyzed."[7] Until a market correction takes hold, or there is a global shift toward alternative sources of fuel, oil demand will continue and, perhaps increasingly, will influence the global security environment. DOD has the opportunity to take action to shape this future to our advantage.

High Demand and High Costs

The speed with which military forces have deployed and engaged has depended on the speed and adaptability of the logistics tail, which has adapted and evolved to provide the ever-increasing demand for fuel that our

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Filling fuel barrels at observation post in Iraq

U.S. Marine Corps (Tasha M. Fontaine)

newest platforms demand. Because of our tremendous logistics capability, the Armed Forces can be successfully deployed and employed anywhere in the world for both deterrence and combat operations. However, that capability comes at a high price: a tremendous energy demand.

The energy consumption rates of our forces in Iraq and Afghanistan, for instance, is four times what it was in World War II and twice that of Operations *Desert Shield* and *Desert Storm*.[8] The logistics tail now consists largely of the fuel required to execute and sustain operations:

- An Army heavy division may use 20 to 40 times the daily tons of fuel as it does ammunition—about 600,000 gallons per day.[9]
- Of the top 10 battlefield guzzlers, only 2 are combat vehicles—the Abrams tank and the Apache helicopter—ranked fifth and tenth, respectively. The other eight carry fuel and supplies.[10]
- Over half of the fuel transported to the battlefield is consumed by support vehicles, not vehicles engaged in frontline combat.[11]

Delivering fuel where and when it is needed is a significant and increasing burden on the Services. The logistics costs to deliver fuel include people, training, platforms (for example, oilers, trucks, and tanker aircraft), and other hardware and infrastructure. Those costs can be tens and sometimes hundreds of times the cost of the fuel itself, depending on how it is delivered. However, the exact costs are unknown because acquisition and operational decision processes neither fully quantify those costs nor consider alternatives to the "logistics systems" that platform acquisition and perhaps operational decisions will dictate.[12] It is likely that actual costs of delivering fuel for operations are dramatically higher than decisionmakers realize.

Until now, the methods for acquiring military platforms, both combat and support, and accounting for the costs of fuel to operate and sustain them have been sufficient. However, is the confluence of new and evolving operational concepts, high fuel costs, and fiscal constraints demanding a transformation in our view of energy? The available evidence suggests that it is.

New Technology Vectors

Historically, the Department of Defense has invested in transformational technologies—such as nuclear power, missile defense initiatives, and intercontinental ballistic missiles—with the potential to alter the strategic balance. DOD should do the same now to balance its scarce energy resources. New technologies to improve fuel efficiency (weight, drag, engine efficiency, system efficiency, and auxiliary power needs) and to develop alternative energy sources have the potential to transform the force, remove operational limits that are built into our plans, and provide the capabilities that forces need. The business case for investing in new technologies, however, is difficult to build because current costing methods do not make the actual end-to-end costs of fueling the force visible to decisionmakers.

In *Winning the Oil Endgame*, Amory Lovins identifies some key technology investments in various stages of development that could significantly improve military weapon system efficiency and operational performance.[13] Investing in these technologies gains energy efficiency and explores alternative fuels and energy sources. About $250 million (0.4 percent) of the DOD fiscal year 2006 research and development (R&D) budget can be tracked to energy-related projects to include:

- Army: Propulsion and Energetics Program, University Research Initiative Fuel Cell R&D, Advanced Propulsion Research, Combat Vehicle and Automotive Technology (includes numerous projects on fuel cells, lightweight materials, and reengineering of vehicles), and Services Combat Feeding Technology Demonstration
- Navy: Navy Energy Program, Mobility Fuels/Fuel Cells, Integrated Fuel Processor/Fuel Cell System, Solid Oxide Fuel Cell, Commercial Off-the-Shelf Carbon Filter Qualification, and Energy and Environment Technologies (fuel cell and methane hydrate technologies)
- Air Force: Integrated High Performance Turbine Engine Technology Program (to double the 1987 state-of-the-art turbine engine thrust-to-weight ratio) and Dual Use

Refueling tanker truck for forward operating bases in Iraq

U.S. Marine Corps (Brian A. Jaques)

Science and Technology (fuel efficiency is an explicit area of interest but is a small part of overall project)

- DOD: Vehicle Fuel Cell Programs, Fuel Cell Locomotives (congressionally added programs), Advanced Power and Energy Program, Weapon and Energy Sciences (includes research on energy and fuel), Syntroleum Project (to convert natural gas into liquid fuels), and Hydrogen Fuel Cell Electric Hybrid Vehicle.

The actual level of DOD investment may be higher because research within other program elements may include platform-specific energy concerns. Nevertheless, even if the level is doubled or tripled, it would be a small investment compared to the investment in other strategic initiatives such as missile defense. More important, an investment in energy-efficiency R&D and, ultimately, oil independence may have a far greater impact on the strategic balance.

An inherent tension exists within the tiered-system approach that DOD takes to science and technology (S&T). On one hand, wide-ranging S&T investment provides a mechanism for discovering new knowledge and developing things that would not otherwise exist. On the other hand, most successfully fielded military S&T is directed toward operational and programmatic needs. While at least seven different fuel cell efforts are under way, the low level of investment in energy efficiency R&D may indicate that energy efficiency is not being pursued with urgency or an overarching strategic view toward transforming the way we plan, operate, and fight. The following areas may provide a basis for such an overarching DOD energy strategy.

Invest Strategically in Energy Technology. By significantly increasing its R&D investments, DOD can improve the efficiency and capability of the current force. These investments will require the establishment of a strategic transformational mandate for significant near-term energy-efficiency improvements (such as retrofit of existing platforms that will be part of the force for several years), reduced logistics force requirements, and long-term military and national energy independence from foreign energy sources (including new

USS *Blue Ridge* being refueled by USNS *Walter S. Diehl*

USS *Blue Ridge* (Marc Rockwell-Pate)

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efficient platforms powered by alternate energy sources). The technologies considered should be far-reaching, with the specific view of their potential both to provide the lethal force required in the execution of military operations and to provide that force more effectively and efficiently. In other words, although recent operations have demonstrated the usefulness of heavy forces, a smaller, more responsive, and more affordable force might better meet capability demands than a larger, slower force that is more expensive to operate.

an inherent tension exists within the tiered-system approach that DOD takes to science and technology

Revisit an Energy Accounting Process. As noted in both a Defense Science Board study and *Winning the Oil Endgame*, providing fuel to military forces has many costs that are hidden from current planning, acquisition, and investment processes.[14] As a result, inefficient and capability-limiting practices have persisted. To rectify these shortfalls, these studies suggest that the Defense Department must transform its culture of treating energy as essentially a "free" good both in operational planning and in acquisition. Specifically, they recommend that DOD identify and fully consider all the costs associated with providing fuel to the force and use this information in modeling and wargaming. Practically speaking, this could mean that DOD would need to develop and implement tools to:

- account for all energy-related costs (procurement and delivery)
- analyze life-cycle costs with actual energy costs and make them explicit in acquisition and R&D investment decisions
- model and wargame actual logistics requirements and limitations as part of the analysis to support operational planning.

In general, a DOD energy strategy could provide the incentive mechanisms for the Services to begin showing a return on investment within a given timeframe.

Embrace Energy Efficiency. The clear articulation of a policy for achieving energy efficiency as a primary aspect of executing a strategy might have substantial implications for military transformation. The rationale for such a policy might include:

- Energy efficiency is paramount to develop a force that is expeditionary, agile, responsive, and sustainable.
- Energy dependence must be reduced to shape the future security environment to our advantage.
- Savings derived from energy efficiency are required to recapitalize and transform the force to have the future capabilities needed.
- Limiting logistics support requirements enhances warfighting capability and reduces costs.
- The Services, combatant commanders, research laboratories, and other major DOD organizations should be allowed to keep a

portion of the savings from innovative initiatives in material, procedures, and doctrine that significantly enhance energy efficiency.

- Enabling the rapid adaptation of new energy technologies to civilian use is required for the Nation's long-term physical and economic security.
- Energy efficiency will not adversely affect military capability.

Stimulate Private Industry. Beyond making DOD more efficient and capable of executing future operations, adapting new energy technologies for civilian use may have a larger strategic impact. The Defense Department can lead or stimulate the culture change—required at all levels of the Nation—to recognize the hidden costs of fuel oil and move strategically to less foreign energy dependence. Only then can the United States become better positioned economically and more secure in a future environment with less volatile energy supplies.

Partnering with industry will perhaps stimulate the development of effective energy technologies, develop expertise, and accelerate the acceptance of new technologies by the military and the public. Elements such as the Defense Advanced Research Projects Agency could begin this partnering effort by sponsoring a private-sector "prize program" to encourage new ideas and approaches and demonstrate DOD interest. Partnering would mitigate some industry risk and could potentially:

- accelerate engineering breakthroughs to adapt current technologies to military vehicles and other civilian uses
- lead to developing and proving the advanced manufacturing processes required for new energy technologies
- create procurement strategies that support new industry and manufacturing plants until private demand can sustain them
- stimulate interest and investment in energy efficiency
- make U.S. industries more competitive in the future oil-dependent energy environment.


55th Signal Company (Danielle Howard)

Military police fill HMMWV before patrol

A true energy strategy must result from careful, reasoned analysis. To this end, lively debate on this vital issue is urgently needed. Each proposed element of the framework should be examined and new directions or alternative elements of a strategic framework suggested.

adapting new energy technologies for civilian use may stimulate the culture change required to recognize the hidden costs of fuel oil

This much is clear: so long as DOD systems and associated logistics are wed to an oil infrastructure, meaningful advances in adaptability and agility and overall force transformation will likely be superficial at best. Moreover, the artificially low prices reported for the cost of fuel do not allow for market adjustments in response to the rising costs of oil. The consequence of this pricing approach is that investments in fuel efficiency appear too expensive in cost-benefit analyses and program tradeoff studies used to prioritize system acquisition decisions. However, investments in fuel efficiency actually create savings opportunities that enable investment in technologies. In turn, these new technologies will help maintain the U.S. military's capability advantage over potential adversaries.

As Britain's Royal Navy discovered more than a century ago, transformation relies on new and diverse sources of power. By divorcing DOD systems and infrastructures from oil, we can easily imagine new operational capabilities, an adaptive logistical system, and a radically altered strategic landscape. **JFQ**

NOTES

[1] Nicholas A. Lambert, *Sir John Fisher's Naval Revolution* (Columbia: University of South Carolina Press, 1999).

[2] Jon Tetsuro Sumida, "British Operational Logistics, 1914–1918," *The Journal of Military History* 57, no. 3 (July 1993), 447–480. Also see Erik J. Dahl, "Naval Innovation: From Oil to Coal," *Joint Force Quarterly* 27 (Winter 2000–2001), 50–56.

[3] Defense Science Board Task Force on Improving Fuel Efficiency of Weapons Platforms, *More Capable Warfighting Through Reduced Fuel Burden* (January 2001), 4, available at <www.acq.osd.mil/dsb/reports/fuel.pdf>.

[4] Ibid., 13.

[5] Ibid., 16.

[6] Michael T. Klare, *Blood and Oil* (New York: Owl Books, 2004), 10.

[7] Clayton M. Christensen, *The Innovator's Dilemma* (New York: Harper Business Essentials, 2003).

[8] Sohbet Karbuz, "The U.S. Military Oil Consumption," Energy Bulletin, available at <www.energybulletin.net/13199.html>.

[9] Defense Science Board, 13.

[10] Ibid., 42–44.

[11] Ibid., 19–20. Also see Amory B. Lovins et al., *Winning the Oil Endgame* (Snowmass, CO: Rocky Mountain Institute, 2004), 88.

[12] Ibid., 14.

[13] Lovins et al., 84–93.

[14] Defense Science Board, 15–16. Also see Lovins et al., 87.